Exploratory Problem Set 1-1

1. *Archery Problem:* An archer climbs a tree near the edge of a cliff, then shoots an arrow high into the air. The arrow goes up, then comes back down, going over the cliff and landing in the valley, 30 m below the top of the cliff. The arrow's height, y, in meters above the top of the cliff depends on the time, x, in seconds since the archer released it. Figure 1-1g shows the height as a function of time.

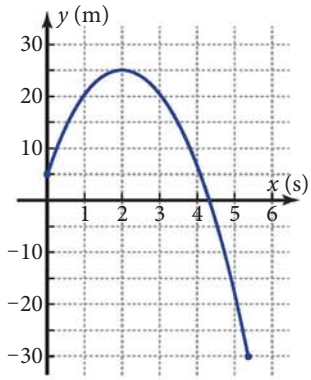

Figure 1-1g

a. What was the approximate height of the arrow at 1 s? At 5 s? How do you explain the fact that the height is negative at 5 s?

b. At what *two* times was the arrow 10 m above the ground? At what time does the arrow land in the valley below the cliff?

c. How high was the archer above the ground when she released the arrow?

d. Why can you say that height is a *function* of time? Why is time *not* a function of height?

e. What is the domain of the function? What is the corresponding range?

2. *Gas Temperature and Volume Problem:* When you heat a fixed amount of gas, it expands, increasing its volume. In the late 1700s, French chemist Jacques Charles used numerical measurements of the temperature and volume of a gas to find a quantitative relationship between these two variables. Suppose that these temperatures and volumes had been recorded for a fixed amount of oxygen.

Jacques Charles invented the hydrogen balloon. He participated in the first manned balloon flight in 1783.

T (°C)	V (L)
0	9.5
50	11.2
100	12.9
150	14.7
200	16.4
250	18.1
300	19.9

a. On graph paper, plot V as a function of T. Choose scales that go at least from $T = -300$ to $T = 400$, and from $V = 0$ to $V = 35$. You should find that the points lie almost in a straight line. With a ruler, construct the best-fitting line you can for these points. Extend the line to the left until it crosses the T-axis and to the right to $T = 400$.

b. From your graph, read the approximate volumes at $T = 400$ and $T = 30$. Read the approximate temperature at which $V = 0$. How does this temperature compare with *absolute zero,* the temperature at which molecular motion stops?

c. Finding a value of a variable *beyond* all given data points is called **extrapolation.** *Extra-* means "beyond," and *pol-* comes from "pole," or end. Finding a value *between* two given data points is called **interpolation.** Which of the three values in part b did you find by extrapolation and which by interpolation?

d. Why can you say that volume is a *function* of temperature? Is temperature also a function of volume? Explain.

e. Considering volume to be a function of temperature, write the domain and the range of this function.